MedicalXpress

A mathematical model simulating the impact of new SARS-CoV-2 strains and vaccines

July 19 2021

Credit: Unsplash/CC0 Public Domain

The MOMAT research group from Universidad Complutense de Madrid has worked with Universidad de Almería, to develop a mathematical model that simulates the impact of SARS-CoV-2 strains and vaccines together, combined with many other biological and social processes in the propagation of COVID-19.

The tool can be downloaded without restriction and free of charge and applied to any territory. It forms part of the family of θ-SIR models, which were initially developed by the MOMAT research group itself before the arrival of new variants and the development of vaccines.

"The model allows us to estimate for the first time what the dynamics of the disease propagation could be. To do so, we have assumed scenarios which quantify uncertainties such as the appearance of new strains and the progress of the rate of vaccination, based on the emergence of data and new knowledge," explains Ángel Manuel Ramos, director of the Interdisciplinary Mathematical Institute (IMI) of UCM.

As well as the parameters already mentioned, the model takes into account others such as different phases of the illness, undetected cases and the impact of control measures.

Monitoring the reproduction number of variants and overall

The article that has just been published in *Communications in Nonlinear Science and Numerical Simulation* has developed and validated the model. It took data from Italy as a reference, with the arrival of what was then called the British strain (now 'Alpha') and the vaccination rate then projected for the country using the vaccines Pfizer-BioNTech and Moderna. The model at that time estimated that the rate of vaccination was insufficient to prevent a new wave, given the new strain, as was subsequently confirmed.

The researchers highlight that the forecasts in the conclusions published in January have proved accurate, as can be seen in the updated data collected in the first six months of the year and included as a note in the annex to the article. Although it is true that the incidence is now lower

than in January and the percentage of people immunized is greater, the experts recall the initial theory: a new strain may endanger the current vaccination rate's ability to prevent a new wave.

In epidemiological terms, the aim continues to be to lower the effective reproduction number of the disease (Re) to below 1. The model warns that this is not sufficient, given that although Re is below 1, the reproduction number of a specific variant (Re(v)) may be higher, even though the overall number of the epidemic is below 1. In this case, the vaccination rate would have to be increased and security measures enhanced.

"Our model continues to be useful, in particular during the current state of uncertainty with respect to the Delta strain. The same could happen with the Delta strain as with the Alpha, i.e. that the effective reproduction number is over 1, driving the pandemic to a possible new wave, although the figures right now are falling," adds Ramos.

For this reason, he insists, "it is very important to carry out rigorous monitoring at all times of the numbers of people affected with any new variant that is potentially more dangerous and increase the vaccination rate as soon as possible."

An award-winning model that is constantly being updated

The researcher from Universidad de Almería, Miriam Ruiz Ferrández, who belongs to the research group Supercomputación-Algoritmos, insists that "the simulated scenarios (and thus assuming that the hypotheses on the Alpha strain and the vaccination campaign are correct) demonstrate that the current rate of vaccination would be sufficient to eradicate the illness, provided that the restrictive control measures are maintained for

a prolonged period of time. However, if the control measures are relaxed, the current rate of vaccination may not be sufficient to prevent a new wave."

Nevertheless, Ruíz highlights that "these scenarios were simulated for publication of the work at the end of May, when the Alpha variant was predominant; and in the current situation, with the appearance of new strains such as the Delta, we are working on new scenarios in which we have to incorporate their characteristics to obtain updated results."

To make their results better known, the experts have publishedan informational video in which they explain the research. Moreover, on 17 June, the Social Council of the UCM rewarded this group at the COVID-19 Awards in the Research category for the project "Mathematical models as a key tool in the fight against COVID-19".

More information: A.M. Ramos et al, Modeling the impact of SARS-CoV-2 variants and vaccines on the spread of COVID-19, *Communications in Nonlinear Science and Numerical Simulation* (2021). DOI: 10.1016/j.cnsns.2021.105937

Provided by Universidad Complutense de Madrid